II.2 Maintenance of Rice Genetic Stocks and Seed Multiplication of Commercial Rice varieties in Taiwan

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1. Introduction

Taiwan Agricultural Research Institute (TARI) started the colletion of rice varieties, mainly the local native varieties, as early as 1906. Dee-geo-woo-gen, the source of semidwarf gene used in various rice growing countries in the world, was one of them. Since then, various collections of rice varieties were added and maintained. A monograph, of preserved varieties of rice at this institute was published in 1964[10]. Recently an opinion of strenthening the rice germplasm collection and cataloging has led us to review and send the questionaries dealing with this problem to the related stations and institutions for their responses. The results of this survey and the review on seed multiplication of commercial rice varieties in Taiwan are reported here.

2. Maintenance of Rice Genetic Stocks

(1) A total of 2,344 accessions were investigated and cataloged in 1961-1962, and 858 new accessions are available for another investigation and cataloging (Table 1).

(2) A germination test of the stored of rice varieties at TARI was conducted in 1978 (Table 2). Only 10 varieties per decicator were tested. The percent germination of stored seeds varied among desicators and also among varieties within

a desicator. A small cracking was found on Nos. 3 and 24 desicators. A wide variation of the viability among varieties within desicator was probably caused by unproper drying of the seed before storage. The seeds in the number 7 desicator showed a satisfactory percentage of germination even after 10 year-storage.

(3) A survey by sending the questionnaires dealing with the maintenance of genetic stocks to rice scientists in the island was made. We sent 41 copies of the questionnaires and received answers from 25 persons. The results are shown below.

A. To maintain rice genetic stocks by:

Any person who want to do it	One person per station	Any or one person, either way	Period to rejuvenate the seed		Seed storage	
			Year	Station no.	Method	Station no.
8 persons (Var. no. 20-500)	9 persons (Var. no. 94-250)	8 persons (Var. no. 50-3202)	0.5	4	Refrigeration	15
			1-2	16	Room temperature	3
			3	4	Desicator	2
			5	1	No answer	4

B. Scientists in charge of genetic stock and parental variety plots are:

The same person	Different persons	No answer
13	10	2

Table 1. Number of rice varieties investigated in 1961-1962 (10) and new accessions available for investigation and cataloging.

Group or Origin		Nonwaxy	waxy	Upland	Total
Ponlai		416	29	3	2,344
Mainland China		660	21	-	
Taiwan native		396	54	16	
Taiwan highland native			21	46	
Japan		203	35	14	
India			72		
Indonesia			104		
Philippines			91		
U. S. A.			63		
Viet-nam			42		
Others			70		
New	Indica		402		858
Accessions	Japonica		450		
	Others		6		

Table 2. Examples of percent germination of cold-stored rice Seed (9-10°C, R. H. 45-50%). Cold-storage started in 1968 and germination tested in 1978.

Desicator No.	Year harvested	% germination of 10 varieties per desicator									
		5	15	25	35	45	55	65	75	85	95
1	1962-II	3		2	2	1		1		1	1
3	1964-II	9	1								
7	1965-II							1	2	1	6
17	1966-I	3			1	1	2	2	1		
24	1965-II	9	1								
29	1964-I			1	1	1				1	6

C. A large germplasm bank in Taiwan is:

Needed	Not needed, but use IRRI's	Both
20	3	2

D. To request rice seed from :

TARI who maintain seed	Self-provide the seed	IRRI
21 (Actual request ≒1.2 time/year)	4	(Actual request ≒0.69/year)

E. Usefulness of "Monograph of Rice Varieties" (10).

Very useful	Fairly useful	Less useful	Useless	Never seen it
14	5	2	0	4

Apparently, a certain degree of repetition in maintaining the rice germplasm exists even within a station. The duration to rejuvenate the seed was about 1-2 years with a limited number of varieties preserved except at TARI. A majority of answers indicate that a large germplasm bank at TARI is needed for requests of the seed from various stations and institutions in Taiwan. The publication of "Monograph of the Preserved Rice Varieties" by TARI was useful.

F. Other opinions:

a. To publish periodically (5-10 years) the "Monograph of Rice Varieties" according to different traits, including various physiological characteristics such as isozyme patterns.

b. For more acurate maintenance of genetic stocks, we need more man power and dedication.

c. Stabilities of temperature and humidity of cold-storage room and maintenance of cooling system must be improved.

d. IRRI's rice germplasm bank is located too far away for urgent requests. Therefore, TARI should establish a regional germplasm bank, but it needs more man power and expenses.

e. To establish seed preservation and exchange center or laboratory.

f. To establish a small cold-storage room at each District Agricultural Improvement Station (DAIS).

(4) Contribution of rice genetic stocks to varietal improvement of rice:

a. Semidwarf *indica* stocks to the development of T(N)1, Taichung Sen 2, 3, 10, Kaohsiung Sen 7 and Chianung Sen 6, 8, 11 etc.

b. Semidwarf *indica* stocks to the development of *ponlai* varieties, Taitung 27, 28, 29 and Tainung 67.

c. BPH resistant stocks to the development of Chianung Sen 11, 12, Taichung-Sen 10, Kaohsiung-Sen 7, and early-maturing stock to Kaohsiung Sel. 1.

d. Blast disease resistant stocks to the development of Tainan 6, Tainung 62.

e. Other disease and insect resistant stocks to many new testing strains.

(5) Purposes to maintain rice genetic stocks:

1. To provide the plant mat-

erials for breeding and research programs and for educational purposes.

B. To keep original collections, such as Taiwan native and *ponlai* rice varieties.

C. Germplasm conservation: To set up sanctuaries (example: Taoyuan wild rice), or a large scale germplasm bank to prevent genetic erosion. For this, the more accessions the better, regardless of their values of immediate use.

3. Seed Multiplication of Commercial Rice Varieties

(1) *Before* 1957 (before the adoption of a complete system of seed certification)

The hierarchic system of rice seed multiplication was started in Taiwan as early as 1924 (13,14), although the present author could not find any literature dealing with this topics published before World War II.

A few years after the War, Taiwan Provincial Department of Agriculture and Forestry (PDAF) received a few projects subsidized by Joint Commission on Rural Reconstruction, one of them was on the seed multiplication of rice.

In the meantime, a large scale seed multiplication program on *ponlai* rice was launched in 1953 as a part of the first 4-year-economic-construction plan (1953-1956). The detail is shown in Table 3. In each of these four years, more than 10,000 metric tons of extension seed with the highest of 15,762 metric tons in 1955 were produced (16), enough to cover more than 200,000 ha. of paddy fields, so that the farmers could renew their seed lots once every three years.

(2) *After* 1957

A complete system of seed certification has been adopted in Taiwan since 1957 (1,6) although the certification standards for each class of seeds were realistically revised. The projected

Table 3. Seed multiplication of ponlai rice in 1953-1956.

Year	Foundation seed		Stock seed		Extension seed	
	ha	M.T.	ha	M.T.	ha	M.T.
1953	7.99	19.41	120.7	344.2	4,692	12,870
1954	8.07	22.63	155.9	473.3	5,461	14,616
1955	7.93	24.43	152.1	463.2	6,132	15,762
1956	5.88	15.40	93.9	264.7	4,136	11,495

Table 4. Rice area (ha) having seed-renewed in 1953-1956.

Year	Ponlai (Japonica)	Chailai (Indica)	Upland rice	Total
1953	190,481	111,538	-	302,019
1954	173,362	101,196	-	274,558
1955	198,218	99,157	13,133	310,508
1956	164,647	65,967	14,230	244,844

amount of extension seed that were certified in 1959 and 1960 decreased, respectively, to 6,870 and 8,257 metric tons [2], that could allow the farmers to renew their seed lots once every five years.

The amount of qualified extension seed produced each year continued to drop to 4,000-5,000 metric tons or to the lowest of about 3,000 metric tons (1973) during past 15 years (Fig. 1). Several setbacks during 1970-1974 were attributed mainly to the poor germination percentage and low volume-weight of the seed caused by unfavorable weather in the central and northern districts [17,18].

In the 1960s, less than 500 metric tons of qualified extension seed of *indica* rice varieties were released each year, despite the fact that a total area of about 200,000 ha of paddy fields were planted to this type of rice. After releases of long-grain *indica* varieties in 1974, this amount increased considerably but decreased again to about 500 metric tons in 1979. The area planted to *indica* rice in Taiwan has been dropping at an annual rate of 9,615 ha. since 1948 with the latest figure of 66,789 ha. in 1979, including waxy varieties.

Starting from the early 1960s, efforts were made to concentrated stock seed increase in the first crop, so that extension seed could be produced in the second crop. The foundation seed would be increased in the first crop (Fig 2). The arrangement for these three steps on a seasonal basis seemed to simplify the distribution of seeds, supervision work and to ease some of the rush in certifying the large number of extension seed lots during the summer [2]. As Fig. 2 shows, this arrangement looked good for foundation seed and stock seed increases but not for extension seed production. As mentioned

in the following paragraphs and illustrated in Fig. 3, 6, 7, 8, low yielding second rice crop under unfavorable weather for rice growth is very disadvantageous for the production of a large number of extension seed lots.

(3) *Cooperative seed production*

Due to the small-farm system of this country, about 5,000 metric tons of extension seed needed by rice growers every year were produced by more than 1,000 farms scattered practically all over the island. Because of this, efforts made to improve seed quality and the efficiency of related operations achieved only limited success. In 1970, instead of producing extension seed in all townships, each hsier was divided into three sections, and only one township per section produced the seed under join-farming system (20-50 ha.) for the entire section[3]. Field inspection was, on the other hand, facilitated by installing 35 licensed field inspectors[3]. The cooperative seed production system, although not accepted by a majority of seed growers, is still continued at present, particularly by the so-called authorized supplemental extension seed growers. The main criticism against this measure was the extra-expenses needed for seed transportation on delivery, but above all is the difficulty in arbitrating the local seed growers to reach an agreement for cooperative efforts.

(4) *Seed certification*

A modernized system of seed certification was put into practice in 1957 following the conclusion of the First Far East Seed Improvement Conference held in Taipei in 1956(1,2,5). During the first three years, TARI, DAIS's and hsien/city government were responsible for the inspection and laboratory test of foundation, stock and extension seeds, respectively. Later Seed Technology Section,

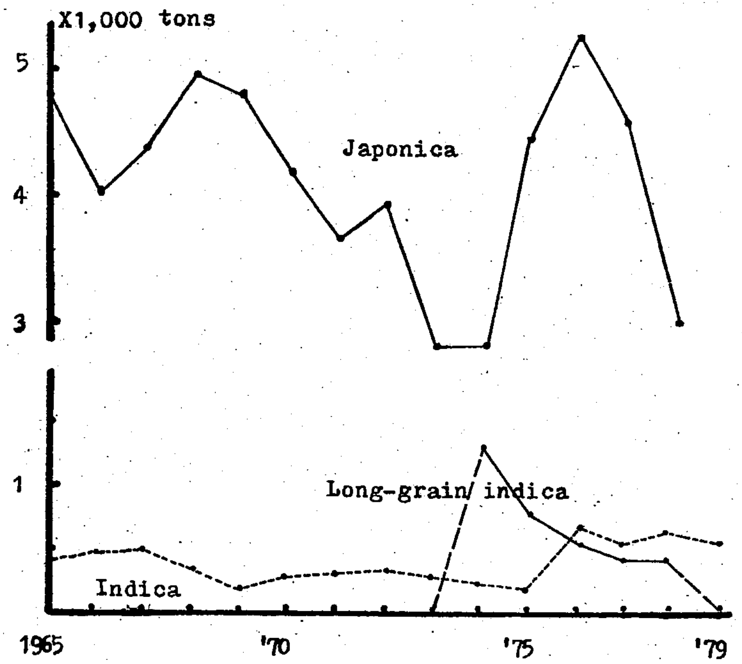

Fig. 1. Total amount of qualified extension seed per year produced in Taiwan in 1965–1979 (excluding waxy varieties).

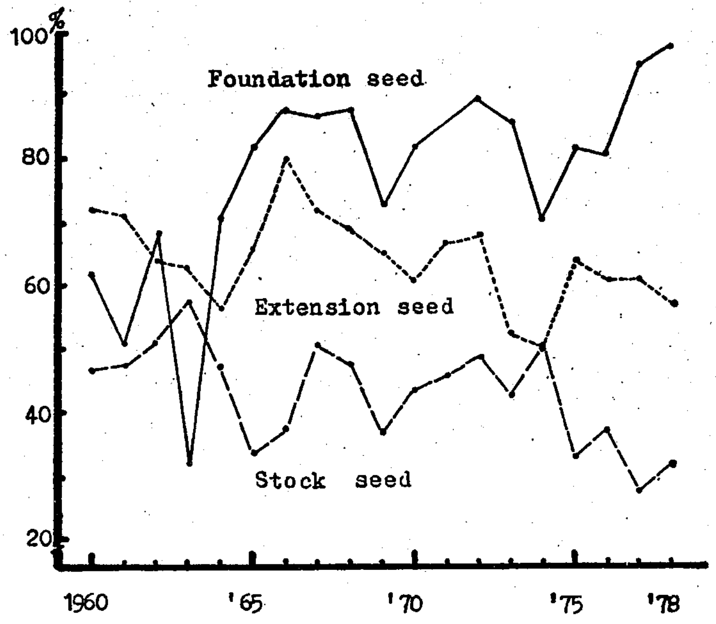

Fig. 2. Percentage of qualified seed produced in the second rice season (non-waxy ponlai only).

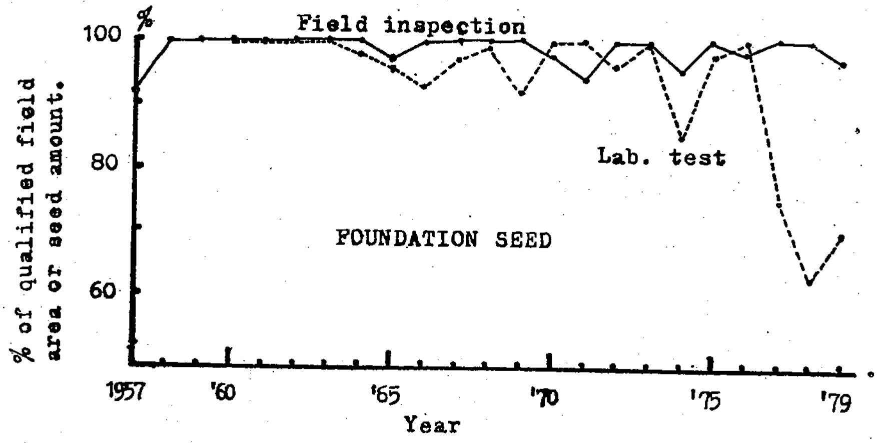

Fig. 3. Rice seed certification on foundation seed in the past 20 years (non-waxy ponlai only).

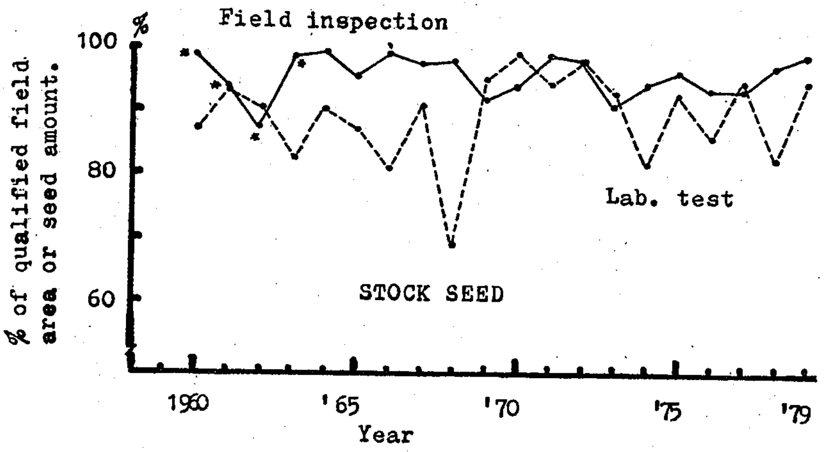

Fig. 4. Rice seed certification on stock seed in the past 20 years (*, estimated from seed samples), (non-waxy ponlai only).

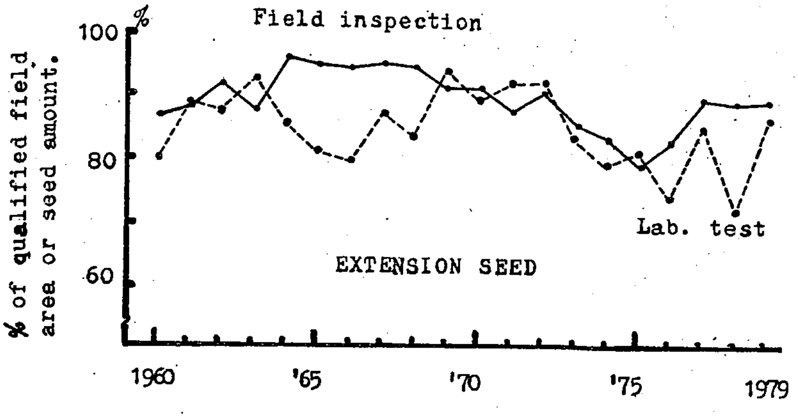

Fig. 5. Rice seed certification on extension seed in the past 20 years (non-waxy ponlai only).

PDAF was established in 1959 and has been actively in charge of seed certification work since 1960. The results of field inspection and laboratory test on all classes of *ponlai* rice seeds during past 20 years are illustrated in Fig. 3, 4, 5 [17,18]. The percentage of foundation seed that passed the laboratory test tended to drop in recent years, primarily due to the poor germination percentage and volume-weight of the seed caused by unfavorable weather in the second crop of central and northern districts (Fig.3). Extension seed also showed the similar trend (Fig. 5). If we look more in detail on a hsien basis (Fig. 6, 7, 8), we will note how disadvantageous to increase rice seed in the second rice season in the central and northern districts.

(5) *Local extension seed production*

The amount of extension seed produced in the 1970s in Yilan hsien commonly reached 200-300 metric tons every year, while those in the 1960s were along 50 metric tons or even less. The growing season for this seed increase in this hsien has been shifted to the first crop since 1971. On the other hand, Taipei hsien could not overcome this difficulty, since no such seasonal shifting was made (Fig. 6).

Three hsiens in Hsinchu district and Taichung hsien also showed a decline in extension seed production during the past two decades except in Miaoli and Changhua hsiens in 1976, during this year an extra number of seed farms were authorized (Fig. 7, 8).

Yunlin hsien produced a large quantity of extension seed amounted 800-1,200 metric tons every year to support the seed supply in other hsien in addition to its own use (Fig. 9). Extension seed productions in the southern and eastern hsiens are illustrated in Figs. 10, 11,

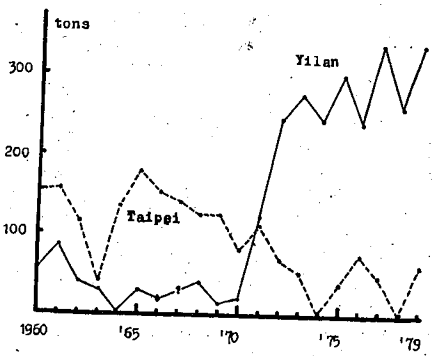

Fig. 6. Amount of qualified extension seed produced a year in Taipei district (non-waxy japonica only).

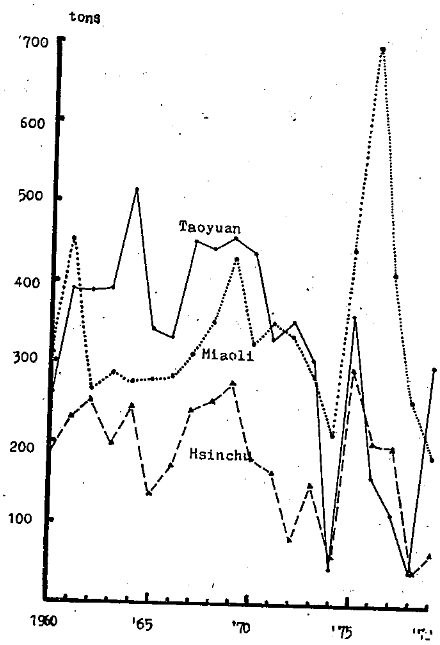

Fig. 7. Amount of qualified extension seed produced a year in Hsinchu district (non-waxy japonica only).

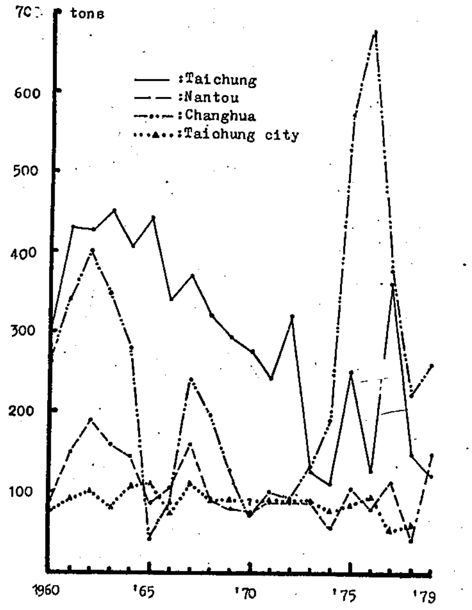

Fig. 8. Amount of qualified extension seed produced a year in Taichung district (non-waxy *japonica* only).

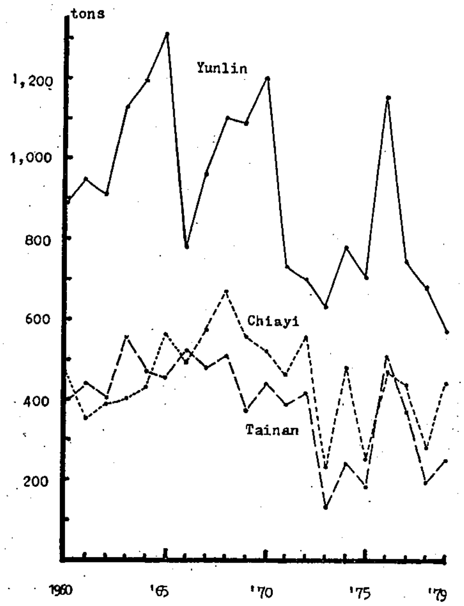

Fig. 9. Amount of qualified extension seed produced in Tainan district (non-waxy *japonica* only).

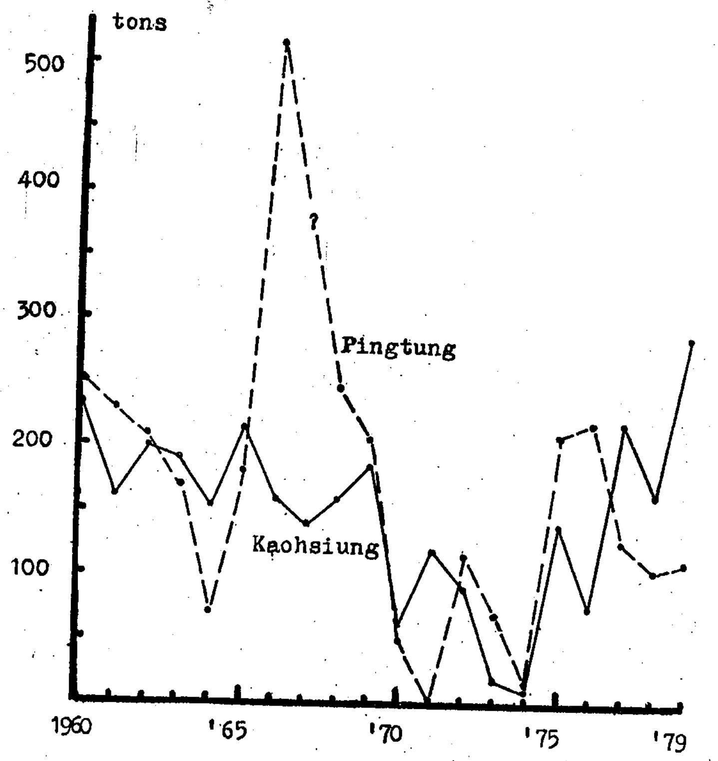

Fig. 10. Amount of qualified extension seed produced a year in Kaohsiung district (non-waxy *japonica* only).

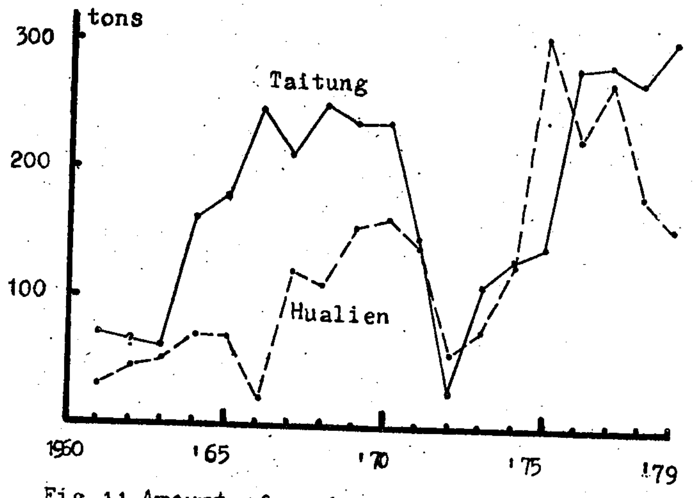

Fig. 11. Amount of qualified extension seed produced a year in East Taiwan (non-waxy *japonica* only).

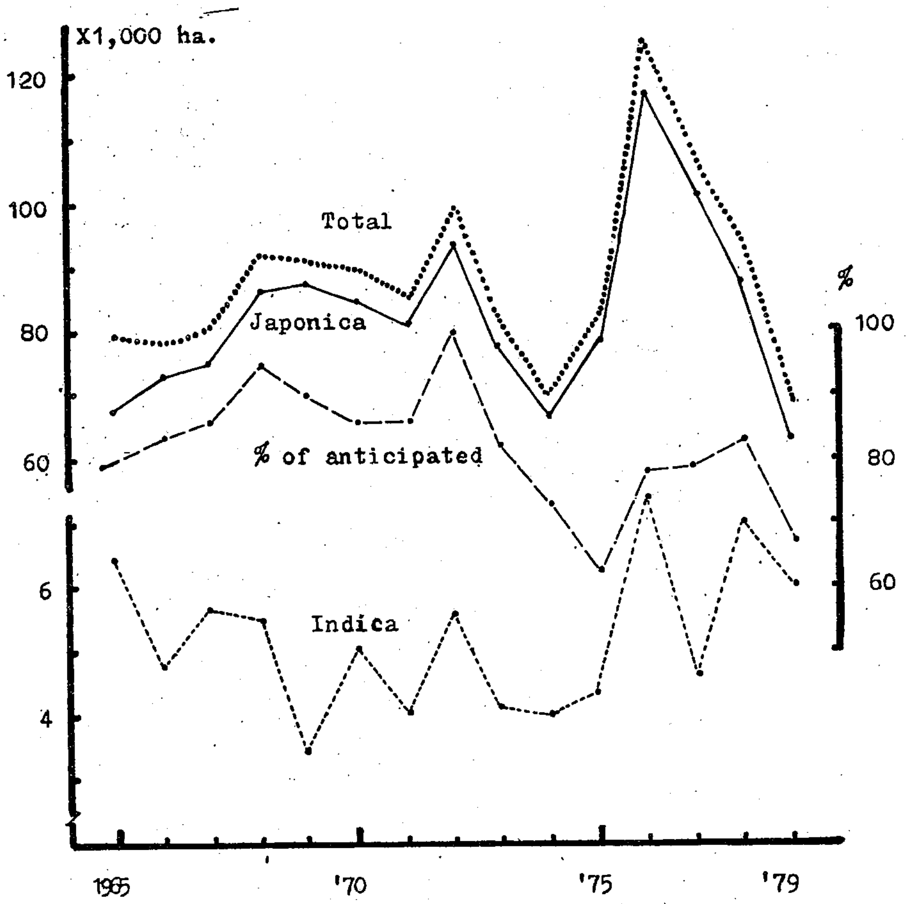

Fig. 12.Rice area having seed-renewed and the percentage of total anticipated area that was seed-renewed each year in the past.

(6) *Rice area having seed lots renewed each year*

As Fig. 12 indicates, the annual rice area having seed lots renewed in past 15 years were along 80,000-100,000 ha. except in 1976[15]. This can give the seed renewal of rice paddy once every 7 years instead of 3 years in 1953-1956. During 1953-1956, the area reached as high as 200,000-300,000 ha. each year (Table 4).

(7) *Impact of cultural mechanization on seed multiplication*

A. *Rice nursery center*: More than 60% of rice area in Taiwan was planted by powered transplantors in 1979. The operators of nursery centers and small private nurseries generally decide which variety to grow or what kind of seed to use, instead of a large number of rice growers of small farms. This change in the planting system will facilitate the supervision and operation of seed multiplication and renewal of seed lots.

B. *Combine-harvesting of extension seed*: Mechanical harvesting commonly introduces the problem of seed mixture. A certain mechanical modification on the present harvestor should be made, so that no seed contamination takes place during harvesting.[17,18].

C. *Seed-drying*: To ensure the viability and purity of the seed during drying.

(8) *Authorized supplemental extension seed*

In the case of urgent need for a large quantity of the seed of a certain variety, PDAF authorizes the DAIS's or hsien governments to increase the seed by ignoring the three-step seed multiplication system. The DAIS's or hsien governments select the seed farms from the ordinary rice fields in which the variety is grown and make appropriate field inspection and tests on them before delivery of the seed.

No certification tag is iss –, and the premium is reduced to 10% instead of 15% for the formal extension seed (17,18).

Example :

1: Chianung Sen 6, 8, and 11 (long-grain *indica* varieties).

2: Tainan 5 to supply seed for integrated demonstration project.

3: Tainung 67 and Taitung 29.

Acknowledgements

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